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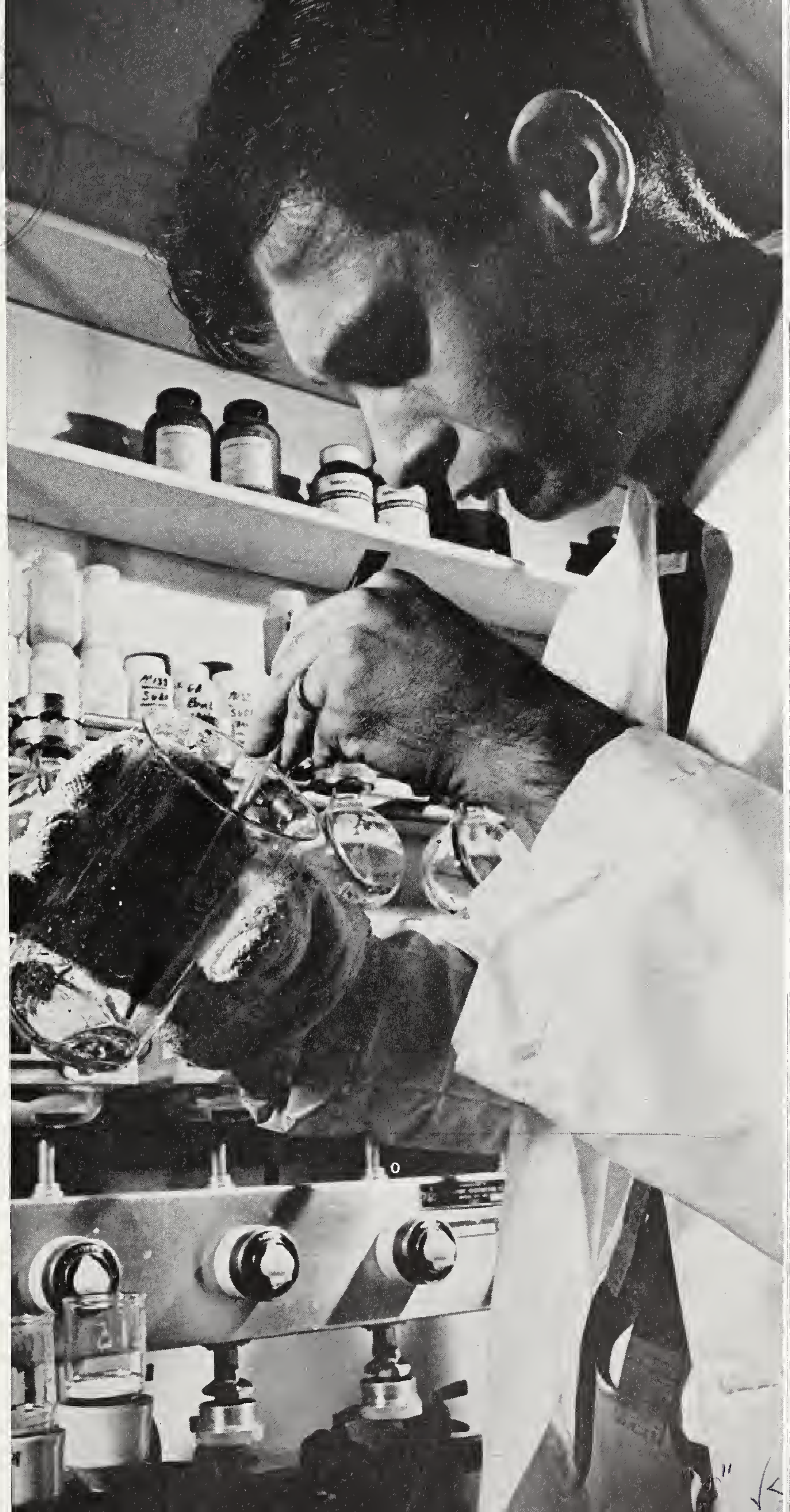

AGRICULTURAL
Research

November 1965/Vol. 14, No. 5

A Search for Beauty

For over three centuries the beauty of America has sustained our spirit and enlarged our vision. We must act now to protect this heritage. . . . Within our cities, imaginative programs are needed to landscape streets and transform open areas into places of beauty and recreation.
(State of the Union Message, January, 1965)

A strenuous nationwide search for the best individual trees available for U.S. cities and towns has been urged by the director of the National Arboretum—as one of numerous USDA activities supporting this Nation's beautification effort.

"A vast number of ornamental and shade trees will be planted during the next decade or two," said H. T. Skinner, speaking recently to members of the Society of Municipal Arborists. "We must be sure that we have the very best trees—those that can be used to propagate planting stock to beautify our streets and parks."

Trees of today live in a different environment than those of a New England village square in 1860. Crowded by pavement and buildings, today's shade trees must survive smog, insects, and disease. Only the hardiest live and maintain the desired shape, branching, shade, color, and root system. It is this type of tree that is being sought—species that are vigorous, clean, and attractive.

But the list of specifications is even longer: Trees for beautifying our streets and parks must have roots that do not buckle pavement, limbs that do not snap under the weight of snow and ice, and foliage and blossoms that truly "sustain our spirit and enlarge our vision."

The need for superior shade and street trees can be fully met only through concentrated introduction and breeding programs. An illustration is the Bradford pear selected from a species introduced from China (AGR. RES., August 1965, p. 2). This flowering ornamental now shades streets in some Eastern States. It is on New Jersey's list of recommended shade trees.

But these are long-range programs, slow to yield dividends. What's needed now is an energetic search by nurserymen and arborists for superior individuals that can help transform drab city streets into avenues of beauty.

Editor: R. E. Enlow
Contributors to this issue:
R. J. Anzelmo, H. L. Brinson,
D. W. Goodman, M. B. Heppner,
F. J. Parks, J. M. Singer,
D. F. Warren

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Orville L. Freeman, Secretary
U.S. Department of Agriculture

G. W. Irving, Jr., Administrator
Agricultural Research Service

Paula Yakley and Henrietta Prichard, research aides, measure the volume of water that infiltrates saturated soil samples, then plot the information mathematically as a curve. This information is used to estimate the amount of rainfall a soil can absorb in a given period after it is saturated.

CAN WE PREDICT FLOOD RUNOFF?

Scientists gather information from 200 watersheds that will help engineers design flood control structures

EDITOR'S NOTE: *This article covers the first phase of the most comprehensive and basic study of agricultural watersheds ever undertaken by the U.S. Hydrograph Laboratory. Other phases of study—five in all—will be reported in future issues of this magazine. These will cover analytical meteorology and climatology, surface-water dynamics, hydrogeology, and watershed performance.*

■ Twenty-four thousand soil samples. have been collected by ARS, will provide data for estimating floodwater runoff from rainstorms on 200 experimental watersheds located throughout the United States.

By analyzing the porosity of these soil samples, and by studying hydrological records, researchers will be able to estimate the amount of rainfall that each soil can store and the approximate rate at which rainfall normally infiltrates each soil.

This information is important to flood control engineers who can combine it with hydrological records and predict the amount and duration of runoff that flood control structures may be expected to convey or contain.

H. N. Holtan, director of the U.S. Hydrograph Laboratory, Beltsville, Md., heads a team of scientists investigating topographic and geologic characteristics affecting runoff on small agricultural watersheds. The University of Georgia is cooperating in the soil-testing phase of the research.

In taking soil samples for this project, the investigators sample a profile of soil 5 feet deep. Because the profile consists of layers of soil which vary in their capacity to store water, the soil must be analyzed to determine—

- The depth of the least permeable layer.
- The rate at which water will move by gravity through the least permeable layer.
- The porosity of the soil layers above the least permeable layer.
- The amount of water that plants can use.
- The amount of water that will drain by gravity from the soil above the least permeable layer.

Not all soils have the same storage

H. N. Holtan refers to a U.S. watershed map that shows areas where soil samples have been collected. This, in turn, is related to major land resources which are shown on the smaller map.

CAN WE PREDICT FLOOD RUNOFF? *(Continued)*

capacity, and even soils with similar capacities react differently during a rainstorm if they have different infiltration rates.

The infiltration rate for each soil varies with the soil property and the length of time and amount of rainfall—the wetter the soil becomes, the slower the rainfall infiltrates until the soil is saturated. At this saturation point, the infiltration rate becomes essentially constant and equals the rate at which water moves by gravity through the least permeable layer.

Since the middle 1950's, major U.S. soils have been classified on the basis of the infiltration rate into saturated soils. The lowest rate of infiltration—that is, the least volume of water that will infiltrate a soil over a specified period of time—can be readily estimated from the soil's classification. And this lowest rate can be plotted mathematically as a curve. Scientists can thus estimate the amount of rainfall that a soil can absorb in a given period after it is saturated.

By adding the volume of water required to saturate the soil to the amount of water that will pass through the soil by gravity after saturation, Holtan can estimate the maximum volume of water that can infiltrate the soil. This maximum volume of infiltration provides an upper limit for estimating the rate of infiltration during a rainstorm and can also be plotted mathematically as a curve.

The curves of the lowest and highest rates of infiltration are nearly parallel. And between these curves, the scientists can plot curves for all possible infiltration rates for a specific soil. These rates cover a range of conditions, varying from wet to dry, fallow to densely vegetated.

The volume of water that will infiltrate a given soil during a specific rainstorm can be estimated from a curve that reflects the maximum volume of infiltration reduced by the amount of moisture in the soil at the beginning of the rain. This, in turn, is reduced by an amount of water which is estimated from the total area of soil occupied by vegetation.

Once the scientists know the volume of water that will infiltrate the different soils of a watershed, they can predict the amount of runoff from any storm or sequence of storms.☆

Developed:
A simple and more accurate method for . . .

Determining TDN

P. J. Van Soest stirs a food sample that was boiled in water containing a weak acid and a detergent. The solution dissolves cell walls, leaving a remnant that includes lignin.

■ A new method to estimate total digestible nutrients (TDN) in feed has been developed by ARS dairy nutritionist P. J. Van Soest. His system is more accurate and simpler than the traditional Weende method.

All nutritionists estimate TDN so they can measure the heat or energy value of a foodstuff and map out balanced rations. Although they can determine digestibility directly by analyzing material eaten and excreted by a test animal, this method is extremely tedious and costly.

The Weende system, devised about a century ago to simplify TDN determinations, mimics in a rough way the body's digestive processes. The feed sample is boiled in weak acid and then in weak alkali. Undissolved material is called "crude fiber," or hard-to-digest material.

Unfortunately, the Weende treatment dissolves a good portion of lignin, which the stomach finds the least digestible of all plant substances. A procedure that includes lignin with other hard-to-digest material would more accurately reveal digestibility.

Instead of continuing attempts to imitate natural digestion in the laboratory, Van Soest based his method on the physical structure of living tissue. Botanists have long held that cell walls are generally made up of hard-to-digest fiber; and material inside the walls, therefore, would be quite digestible.

Van Soest's laboratory work showed that practically *all* the variation in digestibility is due to the structure of cell walls. Cell contents, he found, consistently approach 98 percent digestibility—in lush spring grasses as well as in tough, stemmy legumes.

This finding led Van Soest to split digestibility analysis into two parts, one value for cell walls and another for cell contents. To separate walls from contents involves boiling a food sample in water containing a very weak acid and a detergent. This solution dissolves cell contents, leaving a remnant called "acid-detergent fiber" that includes the lignin—a big advantage over the Weende system.

Lignin can be separated from the other fiber with a much stronger acid bath. Since lignin is the least digestible material in the acid-detergent fiber, the ratio of lignin to total fiber proved to be a good estimate of cell wall digestibility.

Van Soest's two-step analysis, then, goes as follows. Step one: Multiply weight of cell walls by the estimate of their digestibility to find their TDN value. Step two: Multiply weight of cell contents (total weight less weight of cell walls) by 98 percent—the digestibility constant for all cell contents. Add the resultant digestibility of contents to that of walls and you have the TDN value for the whole sample.

ARS is cooperating with nutritionists throughout the world to verify the acid-detergent fiber analysis. Cooperative work on a variety of forages has already shown the new method to be about 90 percent as accurate as the standard—but tedious—direct analysis. Expanded worldwide testing will involve other feeds such as concentrates and human food such as grains and vegetables.☆

WHO'S WHO AMONG CHICKENS

Aggressiveness and pecking order determine social status in the henhouse

■ Who's who in the "pecking order" preoccupies laying hens so much that poultry scientists try hard to understand this aspect of social life in the henhouse. Does, as previous evidence indicates, a hen's egg production and length of life relate to how aggressively she pecks?

Recently, poultry specialists at the ARS Poultry Genetics Laboratory in Athens, Ga., restudied at close range the attitude of one chicken toward another to clarify these specific points:

- Do chicken strains vary in aggressiveness? And does relative aggressiveness of a chicken strain change over a period of time?
- Is aggressiveness related to size? Do birds recognize superiors as individuals—or as belonging to a superior strain?
- Is aggressiveness linked to egg quantity or quality?

Relationships between strains were given special consideration in planning the study.

Poultry specialist R. E. Cook of ARS and J. C. Womack and L. D. Tindell, both formerly of the Georgia Agricultural Experiment Station, studied pairs of hens in a special observation cage. They matched birds from four strains of White Leghorns and two strains of Rhode Island Reds, in three encounters. Although the tests took on some aspects of a tournament, none of the birds were injured.

The first pairings were held when birds were 20 weeks old, the second and third at 38 and 56 weeks. A hen earned points for aggressiveness—if she outpecked her opponent, if her pecks were uncontested, or if the other hen simply withdrew when she threatened. As soon as the researchers could judge which hen dominated the other, they returned the birds to individual cages.

The experiment clearly established that there are superstrains in the chicken world. Each stock revealed a clear level of aggressiveness, which the scientists believe is carried genetically.

In general, the relative aggressiveness of a strain did not change with age. Only in the last rematch did the two *least* aggressive strains exchange standings.

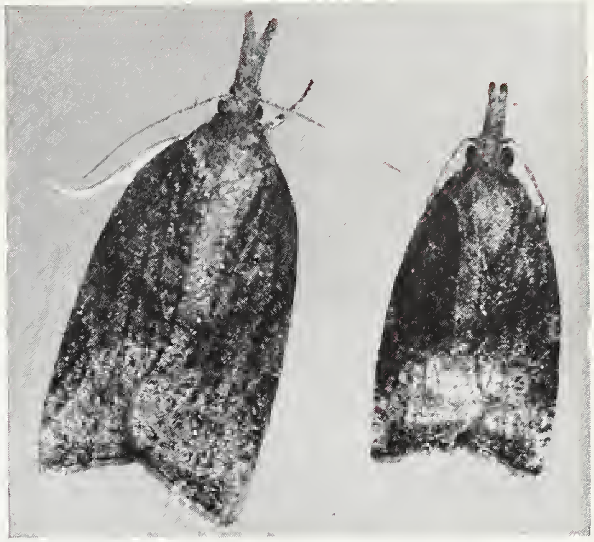
Chickens apparently recognize breeds and strains. Rhode Island Reds clearly yielded to the much smaller White Leghorns, even though within strains the bigger bird was usually the more aggressive. Scientists were uncertain whether breed differences or individual looks were more important for a chicken in recognizing a superior in the pecking order.

Tougher strains were the better producers. The rank of strains by egg production was the same as strainstanding for henpecking, except in one case. On an individual basis, also, the most aggressive birds laid the most eggs.

Egg quality seemed unrelated to aggressiveness.

The most aggressive strain had the lowest mortality; the least aggressive strain, the highest mortality; and intermediate strains in the pecking order had intermediate levels of death losses.☆

Rhode Island Reds yielded to the smaller White Leghorns when they were paired in a cage during tests. When comparisons were made within a given strain, however, larger birds were more aggressive.



Both the codling moth, shown on apple leaf (left), and the omnivorous leaf roller (right) have been sterilized in radiation tests by ARS scientists. The insects are serious pests of food crops.

IRRADIATION

A biological control weapon against omnivorous leaf roller and codling moth

■ Campaigns to eradicate the screwworm in the Southeast and Southwest—through the mass release of insects made sterile by gamma radiation—have been so successful that ARS scientists have been studying this technique as a weapon against other insects.

The omnivorous leaf roller and codling moth are the latest in a growing list of pests that may yield to the sterility technique of insect control.

Both insects are serious pests of food crops, and thus are apt choices as possible targets for biological control rather than by insecticide treatment. Moreover, the omnivorous leaf roller, so called because it attacks more than 40 species of plants, has so far been relatively impervious to insecticides. The larvae draw clusters of small leaves into rolls within which they live and feed; so shielded, they are well protected from insecticide treatments as well as from predators and parasites.

In laboratory studies, ARS entomologists F. F. Smith, A. L. Boswell, and S. W. Jacklin exposed newly emerged, unmated omnivorous leaf roller moths to gamma radiation from a cobalt 60 source, then mated them with normal moths. When male moths treated with 32 kiloroentgens mated with normal females, 99 percent of the eggs failed to hatch. Similar results were obtained when researchers treated females, which are more susceptible to radiation, with only 16 kiloroentgens and mated them with untreated males.

There was no reduction in the number of eggs laid, nor was there any indication that the treated insects were adversely affected in any other way. Field cage studies are necessary before possible practical applications of these findings can be fully evaluated.

In other research, ARS entomologist D. O. Hathaway has sterilized the codling moth by radiation in laboratory and field cage studies at Yakima, Wash. The codling moth is a serious pest of several crops, including apples, pears, quince, and English walnuts. Hathaway found that when male moths treated with 40 kiloroentgens mated with normal females, the following generation was reduced by 98 percent. But no eggs hatched when females were treated with 20 kiloroentgens and mated with normal males. The treated insects showed no other adverse effects.

Hathaway's work was also aimed at determining the release ratio of sterile males to normal males and females that would be required to control the codling moth in the field with the sterile-male technique. This control method requires the release of overwhelming numbers of sterile males to compete with males in the natural insect population. When sterile males mate with normal females, no offspring result.

The field cage tests at Yakima indicated that releases of 30 to 40 treated males for every normal male in the natural population is probably an effective ratio.☆

OPERATING ON THE UNBORN

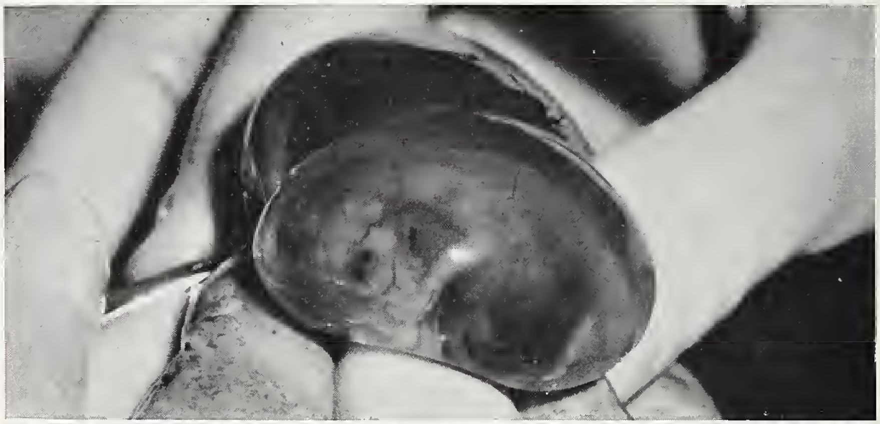
Scientists representing three scientific organizations team up in studies on immunology

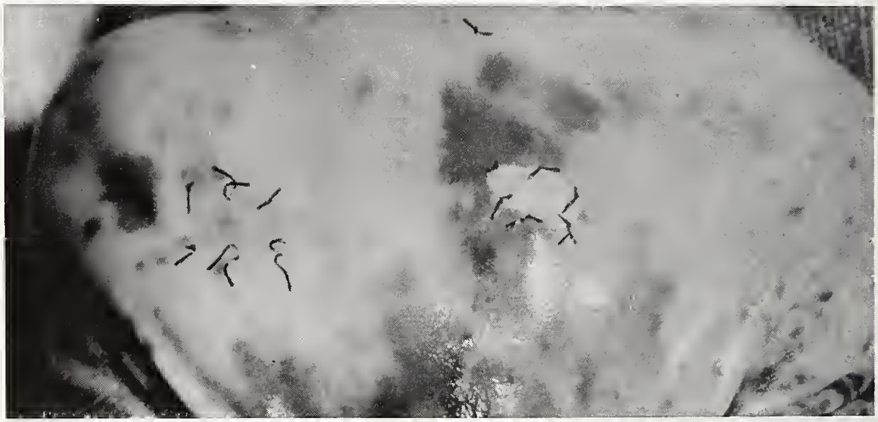
■ Surgical operations on unborn lambs are yielding a triple harvest of basic scientific knowledge for three of the country's leading research institutions.

ARS is in the middle—geographically. The ARS Research Center at Beltsville, Md., is about 30 miles southwest of the Johns Hopkins University School of Medicine in Baltimore, and about half this distance northeast of the Armed Forces Institute of Pathology in Washington, D.C.

Each research group has its special interest in the cooperative project, yet the work is so interlocked that all profit from results obtained.

- Beltsville sheep specialists, directed by geneticist G. M. Sidwell, care for the needed ewes, following a painstaking breeding schedule that provides at the proper time the proper number of pregnant ewes with fetuses at the proper stage of development. Animal fiber specialists led by E. H. Dolnick use the project in basic research on how wool grows.
- Johns Hopkins furnishes most of the facilities for surgery and arranges postoperative care. The university's immunologist, A. M. Silverstein, and research veterinarian, C. J. Parshall, Jr., have a unique opportunity in the cooperative research to study how, when, and why immunological reactions develop in the body.
- The Armed Forces Institute of Pathology contributes the skills of veterinary surgeon K. L. Kraner, an Air Force captain, who uses the project to develop and test surgical techniques for unborn mammals.





TOP—One of these twin sheep fetuses was injected with a protein substance after removal from the uterus on the 35th day of development. Six days later both fetuses—still in their amniotic membranes—were redelivered and compared for antibody development. BOTTOM—Typical reaction to skin grafts is shown on this 107-day fetus. The graft at right is skin from an adult ewe in an advanced stage of rejection. The transplant at left—from the fetus's own body—is being accepted.

Five years ago, before the project began, scientists generally thought that a fetus could not survive operations in which it was taken from the uterus. Now the research team regularly delivers sheep fetuses as early as the 35th day of gestation, treats the partially developed lamb medically or surgically, and returns it to the womb.

The researchers can redeliver a fetus several times during development and replace it each time, until it is finally born in the normal manner at the normal time—150 days after the embryo started to form.

One phase of the project involves transplanting skin onto the fetus at various stages of development, using patches from its own body—or from its mother, its twin, or unrelated fetuses or adult sheep.

Quite early, the research challenged the long-held notion that immune reactions, such as antibody for-

This day-old lamb had a patch of rough thigh wool transplanted to the finer pelt area of its side (dark area) when it was a 72-day fetus. Such grafts are made to determine how different wools develop.

mation or rejection of foreign tissue, take place only after birth. (An adult mammal rejects skin grafts from donors other than itself or its identical twin. That's why fire victims with burns on the arm are frequently patched with skin from their own unburned thigh.)

To the surprise of many, the cooperative study showed that fetuses also reject skin grafts from other sheep—adults or fetuses—after only 80 days of development in the womb. Once the capacity for rejection begins, Silverstein noted, the immature fetus rejects a graft as forcefully and quickly as an adult sheep.

This finding raises a new question: If, for most of its development a fetus rejects transplanted tissues from its mother's body, why don't the placenta (fetal tissue) and the mother's tissues to which it is attached reject each other? Silverstein is eager to discover the answer, which may help find ways to make the human body accept "spare parts" when originals wear out.

Meanwhile, Kraner discovered novel aspects of fetal surgery. "The fetal body," he says, "responds amazingly well. We get first-rate recovery from rather extensive operations. Skin grafts—if they take—heal without scars. And the only trace of a suture is the remaining strands of thread." Medical researchers already are at work—trying to apply Kraner's techniques to prevent birth defects in humans.

Dolnick explains that, in the trial, Kraner has exchanged patches of skin from the side with patches from the thigh early in fetal development. "When lambs were born normally," Dolnick says, "we found an island of coarse thigh wool growing in a sea of fine wool on the lamb's side.

"Apparently the genetic mechanism for wool growth is controlled by the skin on which it grows. Once we understand this mechanism better, there is a far-off chance we may be able to develop a sheep that produces more desirable wool on all parts of its body," Dolnick says.

The researchers continue to work with about 50 ewes and their developing young each year. They hope to keep discovering new information that will serve each of their diverse but interlocked interests.☆

Animal caretaker P. E. Hay holds a lamb, and sheep geneticist G. M. Sidwell holds its dam, used in the fetal experiments. Such tests do not affect normal growth and development. BELOW—This skin graft, made on the lamb shown at left, was purposely transplanted upside down. Even after 4 months, wool growth is still reversed.

LIGHT

An Insect's Nemesis

■ Engineers and an entomologist are testing a specially developed lamp for trapping boll weevils, made according to specifications based on previous light studies.

This is a different approach than has been used in the past. Instead of beginning their work with a series of tests on available lamps, ARS scientists in Texas determined—in the laboratory—the wavelengths of light to which weevils are most responsive. Then they furnished a manufacturer with the requirements for the type of lamp needed.

The research, still in its preliminary stages, is being conducted by engineers J. P. Hollingsworth and R. L. Wright and entomologist D. A. Lindquist, working cooperatively with the Texas Agricultural Experiment Station.

Studies to date have been with boll weevils, but the scientists plan to use the same general approach in work with other insects, including the bollworm (*Heliothis zea* Boddie). The ultimate objective is to establish design criteria for lamps attractive to particular insect species.

Laboratory experiments (AGR. RES., March 1963, p. 12) indicate that weevils respond best to wavelengths in the region of 465 to 515 millimicrons (mμ). This is in the blue-green region of the spectrum. The scientists learned that light in this range is most effective when its peak emission is at about 500 mμ.

As far as the scientists could determine, no lamp with this emission characteristic had been produced commercially. Some lamps emitted light in the proper range, but none peaked at or near the desired 500 mμ.

At the scientists' request, a manufacturer who already had the basic materials in his inventory constructed a suitable fluorescent lamp for experimental purposes. He treated the lamp with a coating of strontium-blue phosphor, which caused it to emit light in the range of 350 to 720 mμ—with a peak emission of about 500 mμ.

In a preliminary field test of the lamp's effectiveness, the scientists covered two rows of cotton with a plastic screen cage 6 feet wide, 6 feet high, and 36 feet long. They then placed the lighttrap in the cage, released marked laboratory-reared weevils, and determined the efficiency of the lamp by the percentage of marked weevils that were trapped. Although the lamp attracted other moth species, it was more selective in attracting boll weevils and other beetles.

Based on results so far, the scientists have concluded that boll weevils can be attracted to an artificial light source. This opens up the possibility of using the new lamp as a tool for surveying boll weevil populations and for controlling this costly insect pest.☆

LEFT—The lower cone of this experimental lighttrap is surrounded by eight 15-watt lamps, each fluorescent strontium-blue. Two other lamps of the same specification are located in the collection container.

RIGHT—In this experimental trap, four fluorescent lamps, each 15-watt strontium-blue, are used with one 100-watt mercury vapor lamp. Two of the 15-watt lamps are not visible.

A Natural Defoliant

Scientists isolate and identify abscisin II, substance that accelerates plant defoliation

■ A natural chemical that accelerates abscission (drop) of flowers, fruit, and leaves in cotton plants has been isolated and structurally identified in ARS-California research.

The chemical—called abscisin II—has the physiological characteristics of a plant hormone.

Three major groups of plant hormones are now recognized: Auxins, gibberellins, and kinins. Abscisin II may be one of a fourth group, or class, of hormones that promote and accelerate abscission.

There are many unidentified hormones in plants, scientists agree; and because hormones affect all phases of plant life, the scientists are avidly interested in developments such as the one reported in the California research.

There is also keen interest in plant hormones from the practical point of view, as is illustrated by the many agricultural uses of synthetics of the three known groups of plant hormones. For example, synthetic auxins kill weeds and promote rooting of cuttings, gibberellins accelerate growth and flowering of trees and shrubs, and synthetic kinins keep vegetables fresh after harvest.

Synthetic chemicals that accelerate abscission would have practical value, also. They might be used as biological defoliants that would be effective in all weather conditions and on all stages of plant maturity, and they might be used to thin fruit at blossom stage or to eliminate postharvest crop growth of perennials such as cotton.

Plant physiologists F. T. Addicott of the California Agricultural Experiment Station and O. E. Smith of ARS led the abscisin II research. They were assisted by organic chemists Kazuhiko Ohkuma and W. E. Thiessen of the California station.

The scientists isolated and crystallized a minute amount of abscisin II (1/3,160 of an ounce) from approximately 500 pounds of cotton bolls, 4 to 7 days old. They determined the structure of the compound by elemental analysis and by comparing it (through mass- and magnetic-resonance spectra comparisons) with known chemical compounds.

Abscisin II promotes leaf drop in other plants as well as cotton, including beans, citrus, and coleus. This indicates that the abscission process is controlled by essentially the same mechanism in different species. It also suggests that the naturally occurring chemicals that accelerate abscission in different plants may be structurally similar.

In further laboratory tests, the researchers found that abscisin II counteracts the effects of growth-stimulating auxin and gibberellin hormones, yet appears nontoxic to plant tissue. Minute amounts inhibited oats from responding to indoleacetic acid (an auxin hormone) and barley from responding to gibberellic acid.

Several scientists have studied abscission-accelerating chemicals since D. J. Osborne, a plant physiologist working in England, obtained evidence about 10 years ago that such substances occur in plants. ARS plant physiologist H. R. Carns and biochemist Wen-chih Liu, formerly of ARS, were among the scientists who made significant findings during this time.

In 1961, Carns and Liu announced the isolation of an abscission-accelerating chemical—which they called abscisin—from mature cotton fruit burs (AGR. RES., November 1961, p. 5). They did not, however, obtain enough of the material to carry their work through to structural identification. Abscisin and abscisin II appear to be closely related chemically.

Other investigations have shown that substances that accelerate abscission are widespread among higher plants. These substances undoubtedly will be subject to intensive studies for many years. There is a likely precedent in the study of auxins—the first auxin was discovered in 1926, and researchers still seek answers to many questions about auxins and their ability to induce physiological changes in plants.☆

EDITOR'S NOTE: *The structure of abscisin II has been confirmed by a group of scientists working independently in England, where they synthesized abscisin II on the basis of the ARS-California identification. They found also that a substance called dormin—that induces dormancy in buds of maple and birch trees—has the same structure as abscisin II.*☆

BUILT-IN INSECTICIDES

Host cotton turns executioner of boll weevils when treated with systemics in Texas and South Carolina studies

■ Developing ways to control boll weevils with systemic insecticides—substances that are absorbed by and move within plants—has been a major goal of cotton-insects research for some time.

ARS scientists now report killing up to 80 and 95 percent of boll weevils in Texas and South Carolina studies, using different methods of applying systemic insecticides. One treatment also looks promising for the control of thrips, spider mites, and carmine spider mites.

(The scientists are examining cottonseed to see if the systemics leave residues. Systemics applied in the prefruiting stage of cotton have not caused a residue problem. Now, they are investigating seed from cotton plants treated in the fruiting stage and will not recommend this treatment until they have determined that residues do not occur.)

At College Station, Tex., entomologists R. L. Ridgway and L. J. Gorzycki and research technician S. L. Jones used a systemic insecticide with a feeding stimulant against boll weevils. In effect, they tricked the weevils into feeding on cotton leaves, to which insecticides are easily translocated.

Although cotton plants contain a natural feeding stimulant throughout their systems, the greatest concentration is present in the squares (flower buds), and weevils prefer to feed there. When squares are not available, weevils will feed on the leaves. By spraying the plant with a formula containing this stimulant, the researchers apparently made the leaves as tasty to the insects as the squares.

Working in cooperation with the Texas Agricultural Experiment Station, the scientists used cyclic ethylene (diethoxyphosphinyl) dithioimidocarbonate, one of the most effective of several experimental systemics yet tried against the boll weevil. On cotton plants just beginning to fruit, they applied the material without the feeding stimulant—as either a soil or stem treatment—and found that the mortality rate of adult boll weevils was "substantial."

On fruiting cotton plants, the entomologists applied the systemic as a stem treatment in a lanolin paste, along with a leaf spray containing the feeding stimulant mixed with sucrose and agar. More than twice the number of weevils were killed by this treatment than when equally well-fruited cotton was treated with the systemic alone.

The kill of boll weevils in the Texas studies—when stem applications, or soil applications at 10 pounds per acre were made—ranged from a high of 80 percent down to about 60 percent during the test periods, which varied from 3 weeks to 1 month.

Continued study is required on the nature of the feeding stimulant and how it can be obtained in quantity, on equipment for applying the systemic and the feeding stimulant, and on whether the systemic has a toxic effect on the plant.

At Florence, S.C., ARS entomologists A. R. Hopkins and H. M. Taft used a newly developed systemic in-

Boll weevils fed on cotton leaves that had been sprayed with a feeding stimulant, and that had absorbed a systemic insecticide.

secticide which was translocated to cotton squares under natural field conditions. The systemic was present in squares in sufficient strength to cause significant kill of boll weevils. Applied as a granular sidedress treatment at rates of 8 to 32 pounds per acre, 2-methyl-2-(methylthio) propionaldehyde *O*-(methylcarbamoyl) oxime killed large numbers of boll weevil adults feeding on cotton squares and boll weevil larvae developing in the squares.

Hopkins and Taft report that up to 95 percent of the adult weevils feeding on treated cotton squares were killed. And in some cases, all of the larvae were killed—none emerged from treated squares.

The scientists also point out that the new systemic shows promise for the control of thrips, aphids, and carmine spider mites, and it possibly will control overwintering boll weevils if applied when the plants are beginning to square. It was ineffective, however, against the bollworm and the cabbage looper.

The researchers, who worked cooperatively with the South Carolina Agricultural Experiment Station, reported no reduction in stand as a result of treatments of up to 32 pounds per acre. Except for an initial burning effect on mature leaves 1 to 3 days after treatments of 8, 16, and 32 pounds per acre, they noted no further injury to the plants and no significant differences in yield between treatments. Even though the rates of application were high, the scientists regard the positive results as representing an important advance in research on systemics.

As with the Texas research, additional work on the new material is needed. For example, researchers now are studying rates of application—to aid in determining whether the treatment can be developed into a practical control measure.☆

Chemosterilants

Now Effective Against Screwworms

■ Male screwworm flies have been sexually sterilized with chemicals that—for the first time—do not reduce their mating competitiveness, in tests by ARS entomologist M. M. Crystal at Mission, Tex.

Before chemosterilants could be used in sterilizing insects reared in a laboratory—or against natural populations of insects—their safe use would have to be established through research.

The development of chemicals that sterilize screwworms without reducing their mating vigor might open the door to sterilizing native male-insect populations. But much research remains to be done. All screwworms used in eradication campaigns in the Southeast and Southwest have been sterilized by radiation, which leaves mating competitiveness in this species unaffected.

In the Texas studies, Crystal tested three chemicals that sterilized screwworms without any apparent loss of competitiveness. One chemical, on the contrary, left treated males four times more vigorous than normal or irradiated males.

The three compounds, referred to as I, II, and III, are, respectively: bis (1-aziridinyl) (hexahydro-1H-azepin-1-yl) phosphine oxide; 1-[bis(1-aziridinyl)phosphinyl] - 3 - (3,4 - dichlorophenyl) urea; and N,N′-tetramethylenebis (1-aziridinecarboxamide). Compound III increased competitiveness among treated flies.

The three materials, all aziridinyl compounds, react with genetic material to disrupt cell division. The aziridinyls are among the most promising chemosterilants yet tested and include such well-known compounds as tepa and metepa.

Continuing his research on the new compounds, Crystal will seek ways to treat large numbers of reared insects under controlled conditions and ways of sterilizing screwworm flies in the natural population. He has mass sterilized screwworm flies under controlled conditions, using an aerosol technique for applying two other aziridinyl compounds, tretamine and thiotepa. Although exposure to spray for as little as 6 minutes was effective, these two compounds reduced mating competitiveness.

The aerosol tests are the first reported application of chemosterilants by this means.☆

S. O. Nelson adjusts a dielectric measuring device used in the RF tests. Scientists use the equipment to expose insects to various intensities and frequencies.

Tuning in On Insects

New radiofrequency treatment could serve as alternate to fumigation of stored grain

■ Fumigation is still the most practical way, in terms of dollars and cents, to kill insects infesting stored grain or seeds. But ARS and University of Nebraska scientists say that exposing stored material to radiofrequency (RF) electric fields creates a kind of "death ray" for insect pests that may eventually be an alternative to fumigation.

Insects die after RF treatment probably because the energy which they absorb from the electric field causes internal heating. Exactly how this happens has yet to be scientifically explained.

The RF treatment is as effective as fumigation but now costs more than three times as much—3½ cents versus less than 1 cent per bushel. ARS agricultural engineers S. O. Nelson and L. E. Stetson are working with entomologist J. J. Rhine of Nebraska on ways to increase RF efficiency, thus lowering its per bushel cost.

Results to date are encouraging. In their most recent series of experiments, the scientists tested RF energy for controlling seven insect species often found in stored wheat, rice, corn, and flour. These insects included rice weevils, granary weevils, lesser grain borers, red flour beetles, confused flour beetles, cadelles, and dermestids.

The investigators placed infested grain samples in small transparent plastic boxes and exposed them to RF electric fields at various intensities and frequencies.

Here are some of their observations:

- Higher RF field intensities usually increase the total number of insect deaths, although precisely how and why this occurs has not been determined.
- Longer exposures are required to kill immature insect forms which develop inside the grain kernels. Presumably, the kernel itself provides some protection at this stage.
- At less intense exposures, more insects are able to survive in grains with a high moisture content. Body fluid lost during exposure is apparently replaced—at least in part—with moisture drawn from the grain.
- Some species are more resistant than others to RF exposure. Rice and granary weevils had the highest death rate and the lesser grain borer the lowest.
- Reproduction is adversely affected in all species. In some, fewer offspring are produced; in others, emergence is delayed for various periods. Overall, reproductive activity in the period between exposure and death was either very slight or nonexistent.

Nelson, Stetson, and Rhine have two basic recommendations concerning future research.

First, they urge a close analysis of those insect and grain characteristics which influence absorption of RF energy—as an aid in selecting the most effective frequency to use against any given species.

Second, they suggest a series of physiological studies to better understand what causes death following exposure.☆

Yearbook cites consumer services

How the Department's services are woven into the fabric of American life is reflected in *Consumers All,* the 1965 Yearbook of Agriculture, recently published by USDA.

Consisting of 128 chapters and 105 pages of illustrations, *Consumers All* contains contributions by 133 scientists and technicians of USDA, State universities and agricultural experiment stations, and public and private organizations. Topics discussed include buying and using food, clothing, household furnishings, and equipment; managing money; caring for yards, gardens, and houses; improving communities; using leisure time; and staying healthy.

In the foreword, Secretary Freeman writes that two of every three dollars of USDA expenditures are for services of primary benefit to consumers. He notes that for more than 100 years the Department has been, in Lincoln's words, a "people's department"—a department of producers and users of the essentials of living.

The yearbook is the latest in a series that dates back to 1849, when the Commissioner of Patents prepared the first annual report of his agency's work in agriculture.

Consumers All is available for $2.75 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

Virus causes polyarthritis in lambs

A joint disease of lambs, polyarthritis, can be caused by a virus as well as by bacteria, injuries, or dietary deficiencies. It is not known whether this is a new virus disease or an old one that had not been recognized earlier. But it is the first reported instance of the viral disease in any animals.

First detected by scientists in Wisconsin, the viral disease is now widespread in many Western States, found by J. L. Shupe, L. F. James, and Wayne Binns of ARS and Johannes Storz and R. A. Smart of the Utah State University at Logan.

The scientists isolated the virus from joints, blood, cerebrospinal fluid, internal organs, and body secretions of lambs suffering from what livestock producers thought was either plant poisoning or "stiff lamb disease." Although lesions were present in many organs, the larger, freely movable joints that bear weight were most frequently and severely affected.

Virus samples taken from these organs were propagated in chicken embryos and used to infect other lambs. No matter how the lambs were inoculated with the virus, all developed signs and lesions typical of field cases, proving that this virus does cause the disease.

Infected lambs recovered when they were penned where they could receive adequate rest, food, and water. Although rarely fatal, the disease causes economic losses to ranchers and much suffering to affected animals. Sick lambs are stiff and lame, have high fevers, lose appetites and weight, are listless, and are reluctant to move because of the pain in their legs.

The Logan scientists observed several Utah flocks in 1962 and found infection rates that varied from 2 to 18 percent. A year later, they found infection rates as high as 66 percent. Reports from scientists in other States show that viral polyarthritis occurs also in Idaho, Wyoming, Nevada, California, Washington, Oregon, Montana, Colorado, and Wisconsin.

Further research on this disease is aimed at finding out how it is spread and how it can be prevented.

Selecting boars for crossbreeding

A farmer wishing to produce more pigs per litter should crossbreed and select boars primarily on the basis of litter size of their *crossbred* daughters.

Research supporting this conclusion is based on a study by ARS geneticist J. C. Taylor, using straightbred and crossbred sows sired by the same boar.

"Boars that helped their straightbred daughters increase the size of their litters somewhat," Taylor says, "weren't necessarily the ones which helped crossbred daughters have large litters. You can't judge a boar's value for transmitting litter size in crossbreeding by the way he performs in straight breeding."

Taylor believes that improvement in litter size by crossbreeding comes about through hereditary factors different from those involved in straight breeding. Farmers wanting to improve litter size, therefore, should test boars specifically for their value in crossing with unrelated sows.

In straight breeding, hereditary factors a boar transmits to his daughters are likely to be much the same as those contributed by the dam. Therefore, straight breeding makes for slow progress. But animals of different

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breeds generally differ more widely in genetic makeup, and sows produced from such crosses usually have a greater potential for large litters.

Sheep ked transmits bluetongue

The sheep ked or tick—which isn't a tick at all but a wingless fly—has been incriminated as a transmitter of bluetongue disease in sheep.

Bluetongue virus is also transmitted by another species, the *Culicoides* fly, a pinhead-sized insect commonly known as a gnat, midge, or punkie. The sheep ked, *Melophagus ovinus*, which frequently infests sheep, is a common blood-sucking fly distantly related to the gnat.

In controlled experiments in ARS animal disease and parasite laboratories at Denver, Colo., veterinarians A. J. Luedke, M. M. Jochim, and J. G. Bowne were able to transmit bluetongue by moving keds from infected to healthy sheep.

Five experiments were conducted to simulate possible natural conditions of bluetongue transfer. In one of these, a single ked was able to transmit the disease to a susceptible host. In other experiments, only a mild form of the disease was transferred, indicating that under some conditions, the virus may require a buildup in virulence.

Bluetongue was first found in the United States in 1948. It has since affected sheep in Missouri, Kansas, Oklahoma, Texas, New Mexico, Arizona, California, Oregon, Nevada, Colorado, Montana, Wyoming, South Dakota, Nebraska, Idaho, and Utah. A seasonal disease native to South Africa, bluetongue is found in northern areas of the United States from the onset of summer to killing frost. It has occurred during the winter and spring months in milder climates.

Using quail in genetic studies

Japanese quail, used for some time in poultry physiology experiments, now have become practical subjects for genetic research as well—thanks to new artificial insemination techniques developed by ARS.

Poultry geneticists H. L. Marks and P. L. Lepore explain that artificial insemination is essential for most ARS genetic studies using quail. This breeding method permits simple identification of the parents of each quail chick hatched even if one male is used to breed several females. Until now, researchers have been unsuccessful in obtaining more than 10 percent fertility by artificially breeding quail, except by difficult, time-consuming methods.

Marks and Lepore solved the problem by developing quick and effective handling techniques. They fitted the micropipette, a common laboratory tool, with rubber tubing and a suction device to collect semen from the male. This same pipette then can be used directly to inseminate four or more hens at an average rate of three birds every 2 minutes for the entire transfer.

Quail are desirable birds for poultry research because their habits are essentially the same as those of chickens. They mature more quickly, reaching maturity in 6 weeks compared with the chicken's 20 weeks, so that more generations can be raised per year. And because of their small size, three or four quail can be caged in the space required for one chicken. In addition, quail reduce the feed bill because 20 of them can be raised to maturity on the feed it takes to raise one laying hen.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

PROTECT
Use Pesticides Safely
FOLLOW THE LABEL

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